CHAPTER 5

INTRODUCTION AND DATA SUMMARY

Section 5.1 Introduction 141

Section 5.1.1 Data Overview 141

Section 5.1.2 Upper Atmosphere Data Base 142

Section 5.2 Data Summary 143

CHAPTER 5

INTRODUCTION AND DATA SUMMARY

Section 5.1 Introduction

Section 5.1.1 Data Overview

For the Workshop Meeting in Virginia Beach, a subset of data representing most of the participating model groups was available for discussion and review. Chapter 3 presents the results of the intercomparisons of that subset of data. Subsequent to the Workshop, the various modeling groups had the opportunity to either update or add to the data sets discussed at the Workshop. Chapter 6 presents the overall revised data sets as of December 1988. The organization of Chapter 6 follows that of Chapter 3 with data from all the models (where available) grouped according to:

1. Photochemistry and Radiation
   - Photodissociation Coefficients
   - UV Heating and IR Cooling

2. Transport
   - Net Radiative Heating
   - Tropospheric Source Tracer Experiment
   - Time-dependent Source Conserved Tracer Experiment
   - Stratospheric Source Tracer Experiment
   - O_3 Column

3. Current Atmosphere
   - Integrated Columns of Trace Gases
   - Cl_y and NO_y
   - Nitrogen Gases
   - Chlorine Gases
   - O_x and HO_x Gases
   - Source Gases

4. Perturbed Circulations and Temperatures

The data presented here provide a detailed summary of the two-dimensional picture of the atmosphere as seen by current atmospheric models. Chapter 6 is intended to serve as a comprehensive set of reference data depicting current capabilities.

Section 5.1.2 Upper Atmosphere Data Base

The Upper Atmosphere Data Program (UADP) at NASA Langley Research Center has been established to serve as a working data base for information on stratospheric trace gases and related parameters. It includes data both from measurements and from model calculations. The UADP data base presently includes measurement data from satellite instruments such as LIMS, SAMS, SBUV, and ATMOS and the initial stages of a compilation of stratospheric balloon measurements. The recent focus, however, has been on assembling two-dimensional results from atmospheric model calculations, principally for use in intercomparison activities. Additional information on the UADP can be obtained from

Dr. Robert K. Seals, Jr.
MS 401A
NASA Langley Research Center
Hampton, Virginia 23665
(Telephone 804-864-2696)

The UADP served as the central focal point for assembly of data for the Model Workshop discussed in this report. A substantial amount of work was required with the principal activities involving the handling of data from the various model groups, incorporation of the desired data into the UADP data base on each model's particular grid, gridding of the model data onto a predefined intercomparison grid, data manipulation to derive sums and ratios, and display of the data in graphical form. For the Workshop itself, selected plots were generated for photodissociation coefficients, UV heating and IR cooling rates, net radiative heating, the three tracer experiments (X, Y, and Z), integrated gas columns, and January model outputs for a set of trace gases (NO_y, NO_x, Cl_y, NO_x/NO_y, HNO_3/NO_2, ClO/HCl, Cl/ClO, OH/HO_2, H_2O_2, N_2O, CH_4, and $CFCl_3$). This was done both using the UADP system prior to the Workshop and with workstations at the Workshop. The workstations utilized both electronic connection to the remote UADP computer and a self-contained approach utilizing optical disks. Subsequent to the Workshop a more complete data set, of both original and gridded data, has been incorporated in the UADP. The plots presented in Chapter 6 cover the complete range of intercomparisons.

Two principal areas of work in dealing with the model data sets were the decoding of data from the wide variety of formats used by the model groups submitting data and the transformation of data from each model's specific spatial grid to the predefined intercomparison grid. At the Workshop a standard data format for future transmittal of data to the UADP was established to address the first area. The issue of data gridding arises from the need to intercompare outputs from different models by taking sums,

differences, ratios, and the like. In order to do this, the data sets must be on a common grid. For the two-dimensional data sets addressed here the desired standard intercomparison grid was confirmed to be

Horizontal: 90° S to 90° N in latitude at increments of 5 degrees

Vertical: $z^* = 0$ to 60 km in increments of 2 km
where $z^* = 16 \log_{10}(1000/P)$
and P is the pressure in mbar

After considerable discussion at the Workshop, it was decided that the most desirable course for dealing with the gridding issue in the future would be for each group to submit data on the standard grid. The basic premise that data interpolation or gridding is best done by the data generating team was a deciding point in this decision. For the present Workshop data, the data gridding has been done at the UADP.

Section 5.2 Data Summary

Data presented in Chapter 6 represents results from sixteen model groups. The groups are designated by the following abbreviations:

AER - Atmospheric and Environmental Research, Inc.
CALJPL - California Institute of Technology; Jet Propulsion Laboratory
CAMBRAL - Cambridge University; Rutherford Appleton Laboratory, U.K.
CAO - Central Aerological Observatory, U.S.S.R
CLKSON - Clarkson University
DUPONT - E. I. DuPont De Nemours & Company, Inc.
GISS - NASA Goddard Institute for Space Studies
GSFC1 - NASA Goddard Space Flight Center
GSFC2 - NASA Goddard Space Flight Center (Fast 2D Model)
LARC - NASA Langley Research Center
LLNL - Lawrence Livermore National Laboratory
MPIC - Max Planck Institute for Chemistry, Germany
MRI - Meteorological Research Institute, Japan
NOCAR - NOAA; NCAR
OSLO - University of Oslo, Norway
WISCAR - University of Wisconsin; NCAR

Brief descriptions for each of these modeling activities can be found in Chapter 4 of this report. Data presented are noontime values for models AER, LARC, MRI, NOCAR, and OSLO. Daytime (daylight hours only) average values are presented for models CAMBRAL, CLKSON, GSFC1, and GSFC2. Finally, diurnal (24 hour) average values are given for models DUPONT, LLNL, and WISCAR.

Chapter 6 contains contour plots for the intercomparison parameters, either as pressure altitude (z^*) versus latitude for a particular month or as latitude versus month. An overall summary of the data plots is contained in Tables 5-1 and 5-2. Tables 5-1 and 5-2 are organized with the columns representing a particular model and the rows a particular parameter or group of parameters. Each entry in the tables corresponds to the page number(s) in Chapter 6 where the plot or plots can be found. Dash mark entries indicate that there is no plot for a parameter for a particular model. Table 5-3 provides a summary listing and page location for the tables in Chapter 6 which provide additional information on each parameter such as the parameter designation, a brief description, the units, and the contour levels for the corresponding plots. Each individual plot has a heading which gives the designation for the plotted parameter, the model abbreviation, and the month of the data (where appropriate). Tables 6-1a and 6-1b describe the plots for photochemistry and radiation parameters. Plots in this group are for one month, typically January. Tables 6-2a, 6-2b, 6-2c, and 6-2d cover the transport parameter plots. The net radiative heating and tracer X plots are generally for the four months of March, June, September, and December. Tracer Y plots are snapshots at six month intervals, and the ozone and tracer Z column plots cover a full twelve month period. Table 6-3a, 6-3b, 6-3c, 6-3d, 6-3e, and 6-3f describe the current (1980) atmosphere parameter plots. These plots are also generally for the four months of March, June, September, and December. Table 6-4 describes the perturbation atmosphere parameter plots which cover the same four months. The four perturbation scenarios are described in Chapter 3 and are designated by A, B, C, and D.

Table 5-1. Data Plot Summary - First Eight Models

	Model							
	AER	CALJPL	CAMBRAL	CAO	CLKSON	DUPONT	GISS	GSFC1
Photodissociation	155-7	158-60	161-3	---	164-5	---	166-8	169-71
Heating and Cooling Rates	194	---	195	196	197	---	198	---
Net Heating	205	206	---	---	207	---	---	208
Tracer X	213	214	---	---	215	---	216	---
Tracer Y	222-3	224-6	227-9	---	230-2	---	233-5	---
O_3 and Z Columns	248	248	---	---	249	---	249	---
HNO_3, HCl, NO_2, and ClO Columns	254	---	---	---	255	---	---	---
NO_y	263	---	265	---	267	269	---	270
Cl_y	264	---	266	---	268	269	---	270
NO_x	286	---	294	---	302	309	---	313
NO_2	287	---	295	---	303	310	---	314
HNO_3	288	---	296	---	304	310	---	314
N_2O_5	289	---	297	---	---	311	---	314
HO_2NO_2	290	---	298	---	305	311	---	314

Table 5-1. Data Plot Summary - First Eight Models (Continued)

	Model							
	AER	CALJPL	CAMBRAL	CAO	CLKSON	DUPONT	GISS	GSFC1
NO/NO_2	291	---	299	---	306	312	---	313
HNO_3/NO_2	292	---	300	---	307	312	---	313
NO_x/NO_y	293	---	301	---	308	309	---	313
ClO	372	---	379	---	386	392	---	396
HCl	373	---	380	---	387	393	---	396
$ClNO_3$	374	---	381	---	388	393	---	396
HOCl	375	---	382	---	---	392	---	396
Cl/ClO	376	---	383	---	389	394	---	397
ClO/Cl_y	377	---	384	---	390	395	---	397
ClO/HCl	378	---	385	---	391	395	---	397
O_3	448	---	456	---	463	468	---	472
HO_2	449	---	457	---	464	469	---	472
H_2O_2	450	---	458	---	465	469	---	472
H_2CO	451	---	---	---	---	468	---	472
O	452	---	459	---	---	---	---	473
OH	453	---	460	---	---	470	---	473
O/O_3	454	---	461	---	466	---	---	474

Table 5-1. Data Plot Summary - First Eight Models (Continued)

	Model							
	AER	CALJPL	CAMBRAL	CAO	CLKSON	DUPONT	GISS	GSFC1
OH/HO_2	455	---	462	---	467	471	---	474
N_2O	527	---	533	---	539	541	---	544
CH_4	528	---	534	---	540	541	---	544
$CFCl_3$	529	---	535	---	---	542	---	545
CF_2Cl_2	530	---	536	---	---	542	---	545
CCl_4	531	---	537	---	---	543	---	545
CH_3CCl_3	532	---	538	---	---	543	---	545
DQ-A	---	---	---	---	---	---	---	---
DT-A	---	---	---	---	---	---	---	---
DQ-B	582	---	---	---	---	---	---	---
DT-B	583	---	---	---	---	---	---	---
DQ-C	584	---	---	---	---	---	---	---
DT-C	585	---	---	---	---	---	---	---
DQ-D	586	---	---	---	---	---	---	---
DT-D	587	---	---	---	---	---	---	---

Table 5-2. Data Plot Summary - Second Eight Models

	Model							
	GSFC2	LARC	LLNL	MPIC	MRI	NOCAR	OSLO	WISCAR
Photodissociation	172-4	---	175-7	178-80	181-3	184-6	187-9	190-2
Heating and Cooling Rates	---	---	199	200	---	201	202	203
Net Heating	209	---	---	---	210	---	---	211
Tracer X	217	---	218	---	219	---	---	220
Tracer Y	236-8	---	239-41	---	242-4	---	---	245-6
O_3 and Z Columns	250	250	251	---	251	---	252	252
HNO_3, HCl, NO_2, and ClO Columns	256	257	258	---	259	---	260	261
NO_y	271	273	275	---	277	279	281	283
Cl_y	272	274	276	---	278	280	282	284
NO_x	315	323	331	---	339	347	355	363
NO_2	316	324	332	---	340	348	356	364
HNO_3	317	325	333	---	341	349	357	365
N_2O_5	318	326	334	---	342	350	358	366
HO_2NO_2	319	327	335	---	343	351	359	367

Table 5-2. Data Plot Summary - Second Eight Models (Continued)

	Model							
	GSFC2	LARC	LLNL	MPIC	MRI	NOCAR	OSLO	WISCAR
NO/NO_2	320	328	336	---	344	352	360	368
HNO_3/NO_2	321	329	337	---	345	353	361	369
NO_x/NO_y	322	330	338	---	346	354	362	370
ClO	398	405	412	---	419	426	433	440
HCl	399	406	413	---	420	427	434	441
$ClNO_3$	400	407	414	---	421	428	435	442
HOCl	401	408	415	---	422	429	436	443
Cl/ClO	402	409	416	---	423	430	437	444
ClO/Cl_y	403	410	417	---	424	431	438	445
ClO/HCl	404	411	418	---	425	432	439	446
O_3	475	483	490	---	498	504	512	520
HO_2	476	484	491	---	499	505	513	521
H_2O_2	477	---	492	---	500	506	514	---
H_2CO	478	485	493	---	501	507	515	---
O	479	486	494	---	---	508	516	522
OH	480	487	495	---	---	509	517	523
O/O_3	481	488	496	---	502	510	518	524

Table 5-2. Data Plot Summary - Second Eight Models (Continued)

	Model							
	GSFC2	LARC	LLNL	MPIC	MRI	NOCAR	OSLO	WISCAR
OH/HO_2	482	489	497	---	503	511	519	525
N_2O	546	---	552	---	558	564	569	575
CH_4	547	---	553	---	559	565	570	576
$CFCl_3$	548	---	554	---	560	566	571	577
CF_2Cl_2	549	---	555	---	561	567	572	578
CCl_4	550	---	556	---	562	568	573	579
CH_3CCl_3	551	---	557	---	563	---	574	580
DQ-A	---	---	---	---	---	---	---	588
DT-A	---	---	---	---	---	---	---	589
DQ-B	---	---	---	---	---	---	---	590
DT-B	---	---	---	---	---	---	---	591
DQ-C	---	---	---	---	---	---	---	592
DT-C	---	---	---	---	---	---	---	593
DQ-D	---	---	---	---	---	---	---	594
DT-D	---	---	---	---	---	---	---	595